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Title: Determination of Bag-out Material Packing Fraction

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Determination of Bag-out Material Packing Fraction

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NNSA National Nuclear Security Administration

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Procedure and Calculations

- Volumetrically determined the amount of water necessary to completely fill the provided canister
- Determined the density of provided materials by directly measuring volume and mass of regularly shaped specimens using a micrometer and analytical balance, respectively
- Provided materials were packed into the canister by hand while wearing leaded glovebox gloves to mimic real procedures
- Canisters were packed as full as possible while still enabling complete closure using the canister lid
- Packed canisters were disassemble and a the weight of each component material was obtained
- Packing fraction was obtained using the calculated bulk density of each material and the packed weight of each component

$$PF = \frac{\sum\left({}^{m_i}/_{\rho_i}\right)}{V_T} \times 100\%$$

PF = Packing Fraction (%)
m = Mass (g)
ρ = Bulk Density (g/cm^3)
V_T = Total Canister Volume (cm^3)

Objective:

Determine the packing fraction (vol.%) of realistically-packed canisters containing bag-out materials to inform criticality safety analysis

Packing Fraction: Bag-out Bag

Contents:

- Partial bag-out bag (sPVC)

Contents	Mass	Volume fraction
Bag-out bag material	727.5 g	35.03%

Canister volume$= 1746\ mL$

$\rho_{sPVC} = 1.20 \pm 0.02\ g/cm^3$

Packing Fraction: Glovebox Gloves

Contents:

- Glovebox gloves (unleaded)

Contents	Mass	Volume fraction
Glovebox gloves	767.8 g	30.59%

Canister volume= 1746 mL

$\rho_{glove} = 1.44 \pm 0.03\ g/cm^3$

Packing Fraction: Cotton Wipes

Contents:

- Cotton wipes

Contents	Mass	Volume fraction
Cotton wipes	146.9 g	45.70%

Canister volume= 1746 mL

$\rho_{wipe} = 0.18 \pm 0.03\ g/cm^3$

Packing Fraction: Mixture 1

Contents:

- 2.5 Glovebox gloves (unleaded)
- 3 stubs (sPVC + PVC tape)

Contents	Mass	Volume fraction
Glovebox gloves	767.8 g	30.59%
sPVC	106.2 g	5.08%
PVC tape	20.1 g	0.97%
Total	**894.1 g**	**36.64%**

Canister volume$= 1746\ mL$

$\rho_{glove} = 1.44 \pm 0.03\ g/cm^3$

$\rho_{sPVC} = 1.20 \pm 0.02\ g/cm^3$

$\rho_{tape} = 1.19 \pm 0.02\ g/cm^3$

Packing Fraction: Mixture 2

Contents:

- Partial bag-out bag (sPVC)
- 3 stubs (sPVC + PVC tape)

Contents	Mass	Volume fraction
sPVC	693.3 g	33.13%
PVC tape	20.1 g	0.97%
Total	**713.4 g**	**34.10%**

Canister volume$= 1746\ mL$

$\rho_{sPVC} = 1.20 \pm 0.02\ g/cm^3$

$\rho_{tape} = 1.19 \pm 0.02\ g/cm^3$

Packing Fraction: Mixture 3

Contents:

- Partial bag-out bag (sPVC)
- 3 stubs (sPVC + PVC tape)
- 3 cotton wipes

Contents	Mass	Volume fraction
sPVC	534.3 g	25.54%
PVC tape	20.1 g	0.97%
Cotton wipes	28.9 g	1.15%
Total	**583.3 g**	**27.65%**

Canister volume$= 1746\ mL$

$\rho_{sPVC} = 1.20 \pm 0.02\ g/cm^3$

$\rho_{tape} = 1.19 \pm 0.02\ g/cm^3$

$\rho_{wipe} = 0.18 \pm 0.03\ g/cm^3$

Packing Fraction

Gloves

Cotton Wipes

Bag-out Bag

Mixture 1

Mixture 2

Mixture 3